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CONTINUATION-IN-PART
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CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part application of copending nonprovisional United States patent Application No. 09/839,004, filed April 20, 2001, for an APPARATUS AND METHOD FOR MANUFACTURING A TANK.

FIELD OF THE INVENTION

The present invention pertains generally to tanks that may contain matter in fluid, gas, or solid form, individually or in combination. More particularly, the new and useful invention claimed in this document pertains to a tank for withstanding forces placed on the tank, whether above or below a containment such as ground. The present invention is particularly, but not exclusively, useful for withstanding compressive, buoyant, or eccentric forces on a tank and on the contents of a tank.

BACKGROUND OF THE INVENTION

Tanks have been developed for temporary or permanent storage of a wide variety of matter, including fluids, gases and solids, separately or in combination, that may be deployed partially or completely above or below a containment such as ground. Tanks, reservoirs, containers and receptacles (collectively, "tank" or "tanks") have been constructed of a variety of materials, including metals, concrete, fiberglass, and a wide range of resin materials, as well as combinations of those materials. As used in this document, the terms "tank" or "tanks" also include single-walled and multiple-walled tanks, as well as those configurations which include one or more tanks within a larger encompassing tank. The matter or substances stored in tanks are essentially unlimited. Nonexclusive examples include water, petroleum products, combustible materials, waste, and both toxic and non-toxic materials.

Wherever situated, whether above or below a containment such as ground, tanks are subjected to a wide variety of forces. The term "force" or "forces" as used in this document means pressure registered on an object having a surface. Force is a vector quantity characterized by its magnitude, direction and point of application. Forces may act on objects not only individually and concurrently, but also eccentrically. Thus, when one or more forces acts on an object such as a tank, external and internal effects are imposed on the tank. Such forces include, without limitation, compressive forces; hydrostatic pressures and forces; lifting forces caused by buoyancy of an object such as a tank; ground motions, often generating a wide variety of eccentric

force vectors that may be caused by earthquakes, explosions, and the like; wind forces that may generate complex distribution of pressures on surfaces, and hence apply a wide range of loads on a tank, including negative pressures or suctions. As used in this document, the term "compressive force" or "compressive forces" includes the force applied to a top portion of a tank by ground, earth, back-filled earth and other materials that tend to be placed over or on top of a tank. The term "top" as used in this document generally refers to that exterior surface of a tank that is opposite the surface of a tank in contact with a depression or hollow hole formed in the surrounding ground into which a tank has been placed. One or all of such forces, and other forces, may seek to move a tank from equilibrium, compress, dismember, and even destroy a tank used to store fluids, gases and solids either above or below a containment such as ground, rock, water and similar environments.

When forces are applied to a tank, materials stored in the tank not only may be affected, but may be released or discharged from the tank. Released materials may be toxic to man, animals, water, and to the environment as a whole.

Little effort has been devoted to designing and constructing tanks that effectively resist the effect of forces on tanks. To achieve additional enhanced structural stability, although limited, some tanks are provided with higher profiles than customary. Taller but narrower tanks are designed to limit pressures and forces on tops of tanks. In addition, structural members in the general shape of ribs, in a variety of arrangements, have been used to add additional, although limited, stability to a tank. Ribs have been formed on the exterior surface of a tank to attempt to prevent a tank from collapsing following application of compressive or side forces.

All currently available tanks, or modifications of tanks, for eliminating or neutralizing forces on a tank, for avoiding damage to a tank due to such forces, or for avoiding loss of the contents of the tank due to such forces, have several limitations. For example, currently available tanks do not provide resistance to the force of buoyancy. Furthermore, increasing the height of a tank to add strength or durability eliminates choice of the tank where ground depth is of concern. For example, where rock or other adverse consistencies of soil limit the ability to dig to a certain depth, or where laws or regulations prevent extending a tank below a certain ground level, high profile tanks are not useful. In circumstances where tank capacity should be maintained, increasing the height of the tank may not be an option. An obverse solution, namely

lowering the profile of a tank, may increase the probability of compressive forces collapsing the tank. Neither ribs nor a higher profile of tank will counteract or respond to a situation in which ground water, for example, may rise to push against the bottom of the tank, thus either collapsing the tank or forcing it to rise above the level at which should remain.

Therefore, a previously unaddressed need exists in the industry for a new, useful and reliable tank that resists and neutralizes forces on a tank and its contents, while providing enhanced structural rigidity to the tank.

SUMMARY OF THE INVENTION

Given the conventional solutions that do not effectively solve the problem of resisting and neutralizing forces applied to a tank, it would be desirable, and of considerable advantage, to provide a tank capable of resisting and neutralizing forces applied to the tank. The present invention provides numerous advantages in achieving several objectives in connection with a tank capable of resisting forces applied on the tank. At least one advantage of the present invention is that is provides a tank fully capable of resisting compressive, buoyant, and a wide variety of other forces applied to a surrounding wall of a tank.

An object, therefore, of the present invention is to provide a tank is that resists external forces applied to the tank regardless of whether the tank is located partially or completely above or below a containment such as ground.

An additional objective is to resist the effects of internal forces within a tank.

Yet another object is to provide a tank that may be used for temporarily or permanently storing a wide variety of materials and matter including by way of example only, either water or septic effluent.

Another object of the present invention is to provide a force-resistant tank that has a shorter, or lower, cross-sectional profile.

Yet another object and advantage of the present invention is to simultaneously provide all of the advantages noted above, regardless of the shape, size or configuration of the tank.

Still another object and advantage of the force-resistant tank according to the present invention, is its ability to avoid collapse of a tank under comparatively high pressures caused by external forces on the tank, while at the same time avoiding the effects of buoyancy that seek to lift a tank made of plastics or similar materials because of the comparatively light weight of such

plastics or similar materials. By forming the tank of a thermoplastic resin, commonly referred to as polyethylene, and providing one or more molded through columns within a tank, the effect of the force of buoyancy on the tank itself is eliminated because water may rise through the molded through column even though the molded through column may be back-filled or filled with a material such as dirt or earth. In the back-filled or filled molded through column, capillary action will cause water to rise through the fill.

Another advantage and object of the present invention is to provide a tank with a substantially lower profile than tanks currently available on the market, while at the same time providing a tank that has structural stability unaffected by the lower profile. This object is in part achieved by providing the molded through column or molded through columns with walls that add structural stability to the tank as a whole. It is known that providing a tank with a lower profile is often necessary when placing a tank underground in areas where substantial rock formations limit the ability to dig a hole to the depth needed for the conventional taller or higher profile tanks.

Yet another object and advantage of the present invention is the ability of the molded through column or columns to contribute to the tank's resistance to forces applied against the exterior walls of a tank. Each molded through column is formed by a molding process using a resin material that allows the molded through columns to move, bend, or displace in various directions when such forces are applied against the tank, but also to return to a static position if and when the force is removed.

Yet another advantage of the present invention is a tank that is respectively easy to use and to practice, and that is cost effective for its intended purposes.

These and other advantages and objects are achieved in the present invention by providing a tank, and a method for manufacturing a tank. Preferably, the tank is formed of a thermoplastic material and rotationally molded into a container that includes an upper chamber and a lower chamber, a plurality of opposing ports formed with openings in both the upper chamber and lower chamber, and a plurality of molded through tapered columns integrally engageable with the ports. Preferably, the ports are substantially circular. Opposing ports are dimensionally dissimilar to accommodate substantially tapered molded through columns.

The tapered columns, which in a preferred embodiment of the present invention are

molded integrally in the tank, structurally present one or more hollow tubes extending substantially perpendicular from one position in the interior wall through the container and through the opposite or opposing wall. The tapered columns may be positioned anywhere within the container. The mechanical advantages of the present invention are not limited by placement of a tapered column, or the number of tapered columns included in a tank. Likewise, neither the cross-sectional dimensions nor cross-sectional shape of a tapered column is a limitation of the present invention. Use of the one or more tapered columns also allows manufacture of a tank having a lower profile than is possible using any of the known current structural configurations of a tank. The lower profile provided by the present invention is achieved because the plurality of tapered columns may be filled or back-filled with dirt or other material that adds strength and rigidity to the tank. In addition, the lower profile also is achieved at least in part because of the tapered columns which, when back-filled or empty, resist the force of buoyancy against the bottom or lower chamber of the tank, it being understood that although this document refers to an upper chamber and a lower chamber, the container is formed by rotational molding processes as a unitary body

At least one mechanical advantage of the one or more hollow tapered columns is a more structurally durable relationship of the tank as a whole. Each tapered column acts, in effect, as a structurally rigid hollow tube capable of resisting forces applied from above or from beneath the tank, or against the sides of a tank. In a preferred embodiment of the present invention, which provides for molding of the tank and the tapered columns so that both ends of a tapered column are integrally connected to the ports, on application of a force in a direction opposite the force of gravity, the tapered columns respond with a resistive force in the opposite direction. If, however, a force is applied eccentrically against the side of tank, the tapered columns, being made from a flexible, resilient material, both resist the force and react flexibly to not separate from the tank at the two ends of the tapered columns. The tapered columns thus provide a structural element that is both rigid, resilient, and compressible to resist collapse or structural degradation of the tank.

In addition to external forces, another problem is presented by the effect of internal forces, namely forces created within a tank, that may cause a tank to deform, crumple, or collapse (collectively, "deform"). Water, by way of one nonexclusive example, either stationary or in

movement, in combination with the force of gravity, or in resistance to the force of gravity, is known to generate and exert significant forces in a variety of directions. Alone, or in combination with external forces that may be applied on a tank, such forces on water or other fluids stored inside a tank may cause deformation of a conventional tank. The present invention, however, resists not only the effects of external forces, but also internal forces. The tapered columns provide means for releasing forces that may otherwise deform a tank, and also yield without buckling to such forces.

The tapered columns may be partially or completely filled with dirt or other material to enhance the capability of the present invention to stabilize and strengthen a tank. Left empty, however, the tapered columns contribute to resisting the force of buoyancy. If water or other fluids exert pressure on the bottom or side of a tank, the water or fluids rise through the tapered columns neutralizing the force of buoyancy on the tank. In addition, the tapered columns allow manufacture of a tank in virtually any configuration of length, height, width, or profile. The result is a tank that neutralizes a variety of forces, while also providing a stronger, less buoyant, better stabilized, lower profiled tank resistant to forces applied on, under, or against the tank.

In an alternative embodiment of the present invention, the structural element of the hollow tubes may be used and deployed in a tank having more than one wall. Many tanks are formed as a container having an outer wall and at least one additional inner wall. The unique advantages of the present invention are applicable to such a tank. In addition, the apparatus and method of the present invention also applies in environments where tanks are positioned within a larger encompassing tank.

The advantages of the present invention, and features of such an apparatus and method for neutralizing forces on a tank, will become apparent to those skilled in the art when read in conjunction with the accompanying following description, drawing figures, and appended claims.

As used in this document, the terms "upper" and "lower," as in "upper chamber" and "lower chamber," are used only for convenience and differentiation among similar but opposing structural elements, and are not intended to denote a specific direction or orientation of the apparatus. As used in this document, the term "tapered column" is not intended to convey any limitation in connection with shape. While a tapered column may be cylindrical in shape, the tube of the present invention is not limited to a tubular shape. Indeed, a cross-section of a tapered

column may present an unlimited number of shapes and configurations, including, without limitation, a square, rectangle, triangle, circle, or any other shape or configuration. As also used in this document, the term "integral" is intended to be a broad term, referring to a preferred embodiment of the present invention in which a tapered column of the present invention, although recited as an individual component, is formed or molded such that an end of each hollow tube merges integrally with a port of the present invention.

Thus, it is clear from the foregoing that the claimed subject matter as a whole, including the structure of the apparatus, and the cooperation of the elements of the apparatus, as well as the method for making the invention combine to result in a number of unexpected advantages and utilities.

The foregoing has outlined broadly the more important features of the invention to better understand the detailed description that follows, and to better understand the contribution of the present invention to the art. Before explaining at least one embodiment of the invention in detail, it is to be understood that the invention is not limited in application to the details of construction, and to the arrangements of the components, provided in the following description or drawing figures. The invention is capable of other embodiments, and of being practiced and carried out in various ways. Also, the phraseology and terminology employed in this disclosure are for purpose of description, and should not be regarded as limiting.

As those skilled in the art will appreciate, the conception on which this disclosure is based readily may be used as a basis for designing other structures, methods, and systems for carrying out the purposes of the present invention. The claims, therefore, include such equivalent constructions to the extent the equivalent constructions do not depart from the spirit and scope of the present invention. Further, the abstract associated with this disclosure is neither intended to define the invention, which is measured by the claims, nor intended to be limiting as to the scope of the invention in any way.

The novel features of this invention, and the invention itself, both as to structure and operation, are best understood from the accompanying drawing, considered in connection with the accompanying description of the drawing, in which similar reference characters refer to similar parts, and in which:

BRIEF DESCRIPTION OF THE DRAWING

Figure 1 is a perspective view of a thermoplastic molded tank in accordance with the present invention;

Figure 2 is an end view of a tank showing at least one port and one tapered column of the present invention;

Figure 3 is a tilted side view of a tank also showing at least one port and one hollow tube of the present invention;

Figure 4 is a sectional view along the line 1--1 of Figure 1 of an alternative embodiment of the present invention for a multiple-walled tank; and

Figure 5 is a sectional view along the line 1--1 of Figure 1 of an alternative embodiment of the present invention for a tank having one or more tanks within the container of a tank.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Briefly, the present invention provides an apparatus, and a method for manufacturing the apparatus, that includes a container. Preferably, the tank is formed of a thermoplastic material and rotationally molded into a container that includes an upper chamber and a lower chamber, a plurality of opposing ports formed with openings in both the upper chamber and lower chamber, and a plurality of molded through tapered columns integrally engageable with the ports. Preferably, the ports are substantially circular. Opposing ports are dimensionally dissimilar to accommodate substantially tapered molded through columns.

Figure 1 illustrates a tank of the present invention. Referring initially to Figure 1, a tank capable of resisting forces on the tank is shown and generally designated 10. As shown, tank 10 includes a container 12. Container 12 is shown to include an upper chamber 14 and a lower chamber 16 separated by a parting line 18 shown diagrammatically in Figure 1. In fact, during the molding process, preferably a rotational molding process used to manufacture tank 10, parting line 18 is merely a convenient marking induced by the molding process that creates a circumferential contour around the exterior surface 20 of container 12 of tank 10. As used in this document, therefore, the terms "upper chamber" 14 and "lower chamber" 16 assist in describing the interrelationship of the elements of the invention as a whole. During the molding process, upper chamber 14 and lower chamber 16 are integrally joined into unitary container 12.

As also shown in Figure 1, tank 10 of the present invention includes one or more first ports 22. In a preferred embodiment of the present invention, first ports 22a-g are formed in

upper chamber 14 of container 12 of tank 10. Also in a preferred embodiment of the present invention, first ports 22a-g are substantially circular and are formed with an opening 24a-g as shown best in Figure 1. As also shown in Figure 1, tank 10 includes means 26 for access into and from container 12. Preferably, means 26 for access into and from container 10 includes an aperture 28 that may be opened and closed with a lid 30.

As perhaps best shown by cross-reference between Figures 2 and 3, tank 10 also includes one or more second ports 32. In a preferred embodiment of the present invention, one or more second ports 32a-c, as shown best in Figure 3, are substantially circular, and are formed in lower chamber 16 of container 12. In addition, second ports 32a-c are formed with an opening 24h-j. In a preferred embodiment of tank 10, the diameter and all other dimensions of openings 24h-j in second ports 32a-b in lower chamber 16 are less than the diameter and related dimensions of openings 24a-g in first ports 22a-g of upper chamber 14 in container 12.

The dimensional dissimilarity of openings 24h-j and openings 24a-g are to accommodate a unique feature of the present invention in connection with the plurality of molded through tapered columns 36 that are also included with the present invention. Molded columns 36a-c are perhaps best shown in Figure 3. Tapered columns 36a-c extend from second ports 32a-c in a concentrically increasing funnel shaped direction toward first ports 22a-c. In a preferred embodiment of the present invention, first ports 22 and second ports 32 are integrally formed by a molding process respectively in upper chamber 14 and lower chamber 16. In addition, plurality of molded through tapered columns 36a-c, as shown in Figure 3, are likewise integrally engaged with first ports 22 and second ports 32 by molding. Thus, as shown in Figure 3, tapered columns 36a-c are formed with a distal end 38a-c and a proximal end 40a-c. As indicated, distal end 38 and proximal end 40 of tapered column 36 are molded to be integrally attached to first ports 22 and second ports 32.

In a preferred embodiment of the present invention, all components of tank 10, including container 12, upper chamber 14, lower chamber 16, first ports 22, second ports 32 and tapered columns 36 are formed in a molding process using a thermoplastic material. The preferred thermoplastic material is polyethylene. However, neither the thermoplastic material, nor the specific polyethylene thermoplastic material, is a material limitation on the present invention.

One or more rings (not shown) may be used to attach distal end 38 and proximal end 40

within the mold (not shown) for attaching tapered columns 36a-c respectively to first ports 22 and second ports 32.

The use of tapered columns 36a-c as shown in Figure 3, and the configuration of tapered columns 36a-c as tapered from a smaller size opening 24h-j in second ports 32a-c to a larger opening 24a-g in first ports 22a-g, contribute to achieving in part the advantages and objects of the present invention. For example, tapered columns 36a-c, being hollow, provide a means for anchoring tank 10 on ground, or in a recess formed in ground for holding tank 10, by filling or back-filling one or more of tapered columns 36a-c with dirt or other material. In addition, tapered columns 36a-c, being hollow, may be filled with dirt or other material to resist the force of buoyancy from ground water or other accumulating water under tank 10. The force of buoyancy is resisted because water will rise either through a hollow one or more tapered columns 36a-c, or through material used to fill or backfill tapered columns 36a-c. Also, because tapered columns 36a-c are formed of a dense but resilient and substantially flexible thermoplastic material, direct or eccentric forces applied against tank 10 from any direction will allow tapered columns 36a-c to flex in response to the forces, thus preventing collapse or other defomation of container 12 of tank 10. The present invention's ability to resist such forces is particularly useful when tank 10 is used to hold toxic materials or effluent when tank 10 is used as a septic tank.

It will be further evident to one skilled in the art that the distances between the centers of openings 24 in tapered columns 36, and between distal end 38 and proximal end 40 of tapered columns 36, may not be equal in distance or length, and that the lengths of tapered columns 36 may vary within a container 12 of tank 10. Such variation in length, shown merely for diagrammatic purposes as D1 and D2 in Figures 2 and 3, do not affect the operation of tank 10 of the present invention.

As will be evident to one skilled in the art, the unique and novel structural elements of the present invention are equally applicable in situations where a container is formed into a tank being formed of more than a single wall. Accordingly, in an alternative embodiment of the present invention shown by cross-reference between Figures 4 and 5, tank 10 includes a container 12' formed with at least one outer wall 42. In addition, an alternative embodiment of the present invention also includes one or more first ports 22i-l formed in the at least one outer wall 42 or 42'. Further, at least one tapered column 36d-g extends between one or more first ports 22i-l and one

or more second ports 32i-l. In these embodiments of the present invention, outer wall 42 further defines a cavity 44 within container 12, as shown in Figures 4 and 5. Further, the alternative embodiments of the present invention provide at least one inner wall 46. As shown in Figures 4 and 5, the configuration of the alternative embodiments of the present invention are shown by way of example as having inner wall 46 formed by outer wall 42 in tank 10'. Accordingly, the existence of one or more containers 12' within a container forming a tank 10' is not a limitation on the present invention.

As also shown in Figure 5, tank 10' may also include a container 12' formed with an outer wall 42'. The one or more receptacles 48a,b are formed with at least one enclosure 50a,b defining storage receptacles 48a and 48b. Accordingly, in operation, the structural elements and components of the present invention will operate successfully in an environment in which one or more receptacles 48a,b are located within a container 12'.

While the invention shown in drawing figures 1 through 5 is at least one embodiment of the present invention, the embodiments shown are not intended to be exclusive, and are not limitations of the present invention. While the particular apparatus and method for manufacturing a tank as shown and disclosed in detail in this instrument is fully capable of obtaining the objects and providing the advantages stated, this disclosure is merely illustrative of the presently preferred embodiments of the invention, and no limitations are intended in connection with the details of construction, design or composition other than as provided and described in the appended claims.